

## Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.



BUREAU OF AGRICULTURAL AND INDUSTRIAL CHEMISTRY

AGRICULTURAL RESEARCH ADMINISTRATION

U. S. DEPARTMENT OF AGRICULTURE

LIST OF PUBLICATIONS WITH ABSTRACTS

on

BRINING AND PICKLING OF CUCUMBERS AND OTHER VEGETABLES

September 1938 to June 1950

from

COOPERATIVE INVESTIGATIONS BY THE

AGRICULTURAL CHEMICAL RESEARCH DIVISION

SOUTHERN REGIONAL RESEARCH LABORATORY

2100 Robert E. Lee Boulevard

New Orleans 19, Louisiana

and the

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

DEPARTMENT OF HORTICULTURE, NORTH CAROLINA STATE COLLEGE

RALEIGH, N. C.

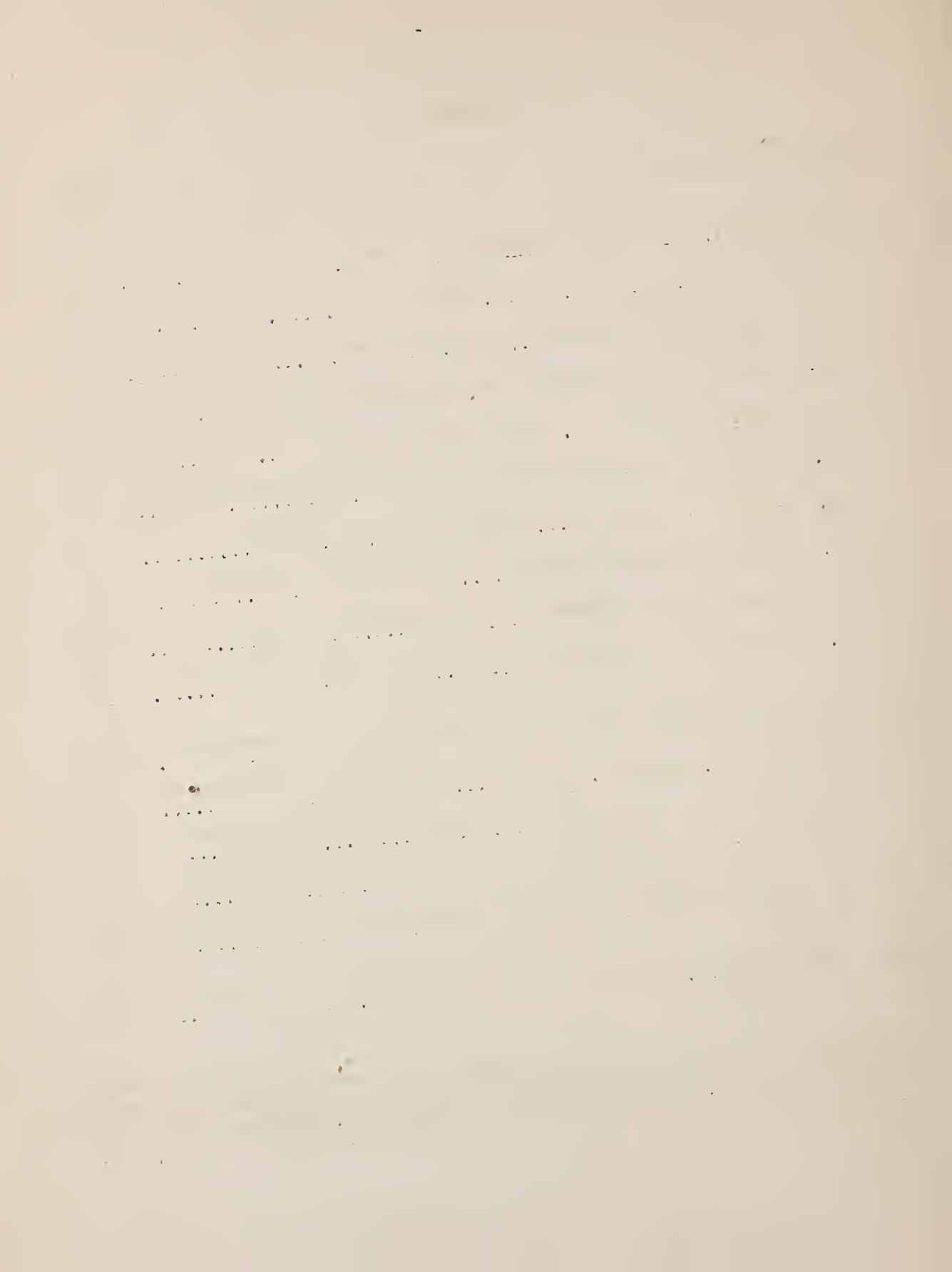
---



CONTENTS

Articles and Bulletins	<u>Page</u>
I. CUCUMBERS: BRINING AND PICKLING .....	3
A. General .....	3
B. Methods and Procedure .....	3
C. Bacteriological Studies .....	4
D. Chemical Studies .....	7
E. Bloaters (Hollow Cucumbers) .....	8
F. Pasteurized Pickles .....	9
G. Softening Enzyme Studies .....	11
H. Varieties for Pickles .....	12
I. Sanitation for Factories .....	12
II. OTHER VEGETABLES: BRINING AND PICKLING .....	13
A. General .....	13
B. Methods and Procedure .....	13
C. Bacteriological Studies .....	14
D. Nutritive Value .....	14
III. MISCELLANEOUS .....	15

Note: Single copies of available reprints may be obtained from Food Fermentations Laboratory, U. S. Department of Agriculture, P. O. Box 5578, Raleigh, N. C., or the Department of Horticulture, North Carolina State College, Raleigh, N. C.



## ARTICLES AND BULLETINS

Article  
No.

## I. CUCUMBERS: BRINING AND PICKLING

A. General

- 1.\* VELDHUIS, M. K., ETCHELLS, J. L., JONES, I. D., and VEERHOFF, O.

NOTES ON CUCUMBER SALTING. Fruit Prod. Jour. and Amer. Vinegar Indus., Vol. 20, No. 11, pp.341-342. (July) 1941.

This article consists of a brief report on the merits of certain brining practices in use at commercial pickle plants. These included the use of sheltered or unsheltered vats, scum control, circulation of brine, painting the inside of vats, and the care of empty vats. The advantages and disadvantages of the various methods studied should prove of benefit to cucumber salters in general.

- 2.\* GORESLINE, H. E.

COOPERATIVE PICKLING INVESTIGATIONS OF THE U. S. DEPARTMENT OF AGRICULTURE. Fruit Prod. Jour. and Amer. Vinegar Indus. Vol. 21, No. 3, pp. 232-233. (April) 1942.

A brief discussion is given concerning the origin, organization, and general accomplishments of the cooperative pickle work being conducted by the U. S. Department of Agriculture and the North Carolina Experiment Station. The period covered in this article represents the years from 1935 to 1941.

B. Methods and Procedure

- 3.\* VELDHUIS, M. K.

THE PRESERVATION OF BRINE SAMPLES FOR CHEMICAL ANALYSIS. Fruit Prod. Jour. and Amer. Vinegar Indus., Vol. 18, No. 1, pp.6-7. (Sept.) 1938.

A method is given for the preservation of brine samples from cucumber fermentations. This permits taking a large number of samples from fermentations during the green cucumber season and keeping them until chemical analysis can be made at a later date. Ten drops of the chemical sodium 2, 4, 5, trichlorophenolate to a pint of brine (1:10,000 dilution) is recommended.

---

\*/ Articles marked by an asterisk (\*) are no longer available in reprint form. They may be found in the journals in technical libraries.



Article  
No.

4.\* ETCHELLS, J. L., and GORESLINE, H. E.

METHODS OF EXAMINATION OF FRESH CUCUMBER PICKLE. Fruit Prod. Jour. and Amer. Vinegar Indus., Vol. 19, No. 11, pp. 331-335. (July) 1940.

Methods of examination for fresh cucumber pickle are outlined with respect to: (a) bacteriological analyses of pasteurized and unpasteurized pickle, and (b) keeping quality of sealed and open jars of pickle. Unpasteurized pickle underwent fermentation by yeasts and lactic acid bacteria. Pickle pasteurized at 160° F. for 20 minutes (in accordance with the equipment and procedure described) retained its fresh appearance and the major portion of crispness over a storage period of several months.

5. ETCHELLS, J. L., and JONES, I. D.

PROCEDURE FOR PASTEURIZING PICKLE PRODUCTS. The Glass Packer, Vol. 23, No. 7, pp. 519-523; 546. (July) 1944.

The pasteurization procedure is discussed in detail together with step-by-step directions for following the rate of heat penetration in various sized containers of pickle. General suggestions and precautions for plant procedure are presented. These deal with the following points: Cleanliness and sanitation; fresh material; handling fresh slices; correct closures; vacuum required; keeping records; container variation; circulation and cooling; and evidence of spoilage.

6. ETCHELLS, J. L., and JONES, I. D.

PROCEDURE FOR BACTERIOLOGICAL EXAMINATION OF BRINED, SALTED, AND PICKLED VEGETABLES AND VEGETABLE PRODUCTS. Amer. Jour. Public Health, Vol. 36, No. 10, pp. 1112-1123. (Oct.) 1946.

Detailed bacteriological methods are given for use in examination of brined, salted, and pickled vegetables and vegetable products. General directions for collection, storage, transportation, and preparation are given for the products as a whole. Individual discussion of the products is presented with respect to: Introductory descriptive material; microbial groups involved; significance of observations; and other remarks incident to the examination. Directions for the preparation and use of differential culture media are combined under a separate section.

C. Bacteriological Studies

7. ETCHELLS, J. L., and VELDHUIS, M. K.

GROWTH OF MYCODERMA SCUM UNDER OIL. Fruit Prod. Jour. and Amer. Vinegar Indus., Vol. 18, No. 9, pp. 265-267; 280. (May) 1939.

The utilization of acid and sugar from cucumber brines covered with mineral oil by a film-forming yeast associated with pickle scum is reported. The results show that although the oil layer did not completely control the destruction of brine acid by the film yeast, a somewhat slower rate of acid utilization was observed when it was used.



8.\* ETCHELLS, J. L.

INCIDENCE OF YEASTS IN CUCUMBER FERMENTATIONS. Food Res., Vol. 6, No. 1, pp. 95-104. 1941.

A part of the fermentation of cucumbers in brine is brought about by yeasts, a fact that heretofore has been unrecognized. Active yeast fermentations were found in brining treatments having initial salt concentrations of 5, 7.5, 10, and 15 percent salt by weight (approx. 20, 30, 40, and 60° sal.). A definite correlation was found between brine concentration and the beginning and duration of the yeast fermentation.

9.\* ETCHELLS, J. L.

A NEW TYPE OF GASEOUS FERMENTATION OCCURRING DURING THE SALTING OF CUCUMBERS. University Microfilms. Publication 282, 153 pp. (June) 1941. (Ann Arbor, Michigan).

Ph. D. thesis, published in bulletin form and abstracted under article No. 11, "The Aerobacter fermentation of Cucumbers During Salting," Mich. Agr. Expt. Sta. Bul. No. 200, 56 pp. (June) 1945.

10. ETCHELLS, J. L. and JONES, I. D.

BACTERIOLOGICAL CHANGES IN CUCUMBER FERMENTATION. Food Indus., Vol. 15, pp. 54-56. (Feb.) 1943.

The predominating microbial groups found in commercial cucumber fermentations during several seasons of study are discussed. A guide to the general relationships in fermentations at 5, 10 and 15 percent salt brines with respect to hydrogen-forming bacteria, acid-forming bacteria, and yeasts is given in table form. The type of fermentation, fermentation activity, chief products formed, and the starting time and duration of fermentation is presented for each group of microorganisms.

11. ETCHELLS, J. L., FABIAN, F. W., and JONES, I. D.

THE AEROBACTER FERMENTATION OF CUCUMBERS DURING SALTING. Mich. Agr. Expt. Sta. Tech. Bul. 200, 56 pp. (June) 1945.

An extensive investigation is presented on the microorganisms responsible for the production of hydrogen in cucumber fermentations. The bulletin is divided into two parts: the first deals with the isolation, identification, and biochemical studies on the responsible organisms. The second part is concerned with the hydrogen and the yeast fermentation of cucumbers under commercial conditions.

Article  
No.

12. ETCHELLS, J. L., and JONES, I. D.

CHARACTERISTICS OF LACTIC ACID BACTERIA FROM COMMERCIAL CUCUMBER FERMENTATIONS. Jour. Bact., Vol. 52, No. 5, pp. 593-599. (Nov.) 1946.

Identification studies on 49 cultures of lactic acid bacteria occurring during the acid fermentation of salt-stock cucumbers, under conditions typical of the industry, are reported. The cultures were isolated from actively fermenting brines ranging in salt content from 5 to 12.5 percent by weight. All cultures gave characteristics typical of those described for Lactobacillus plantarum (Orla-Jensen) Bergey et al. and were placed as this species.

13. ETCHELLS, J. L., and BELL, T. A.

FILM YEASTS ON COMMERCIAL CUCUMBER BRINES. Food Tech., Vol. 4, No. 3, pp. 77-83. (March) 1950.

A study of the types of film yeasts found on 40 commercial cucumber brines, ranging in salt content from 5 to 19 percent by weight is presented. The cultures were classified as follows: Debaryomyces membranaefaciens var. Holl., 18 isolates; Endomycopsis ohmeri nov. sp. 12; Endomycopsis ohmeri var. minor, 14; Zygosacch. halomembranis nov. sp. 9; and, Candida krusei (A. Cast.) Berkhout, 4. Four cultures put in the Debaryomyces genus were not placed as to species.

14. ETCHELLS, J. L., and BELL, T. A.

CLASSIFICATION OF YEASTS FROM THE FERMENTATION OF COMMERCIALY BRINED CUCUMBERS. Incorporated in an address before the National Pickle Packers Association, June 16, 1950, Chicago, Illinois.

During the 1946 and 1947 brining seasons, 1,444 yeast isolates were obtained from 42 fermenting vats at two commercial pickle plants in eastern North Carolina. The isolates were reduced to species in the following six genera in the order of frequency of isolation: Torulopsis, 721 cultures; Brettanomyces, 538; Zygosaccharomyces, 59; Hansenula, 49; Torulasporea, 6; Kloeckera, 1; and 20 isolates not fully classified. The first two genera named represented a total of 1,309 cultures of slightly over 90 percent of all yeasts isolated.

SEE ALSO NOS. 17, 24, 26, and 31.

Article  
No.

D. Chemical Studies

- 15.\* VELDHUIS, M. K., and ETCHELLS, J. L.

GASEOUS PRODUCTS OF CUCUMBER PICKLE FERMENTATIONS. Food Res., Vol. 4, No. 6, pp. 621-630. 1939.

Studies on the composition of the gases produced by commercial cucumber fermentations demonstrated that carbon dioxide was evolved from brines ranging from 5 to 21 percent salt by weight (20 to 80° salometer). Larger volumes of gas were obtained from fermentations at 10 and 15 percent brine strength than at 5, 7.5 and 21 percent strength. Hydrogen was produced in considerable quantities by all fermentations at 15 percent salt. The composition of the gas collected from the interior of "bloaters" (hollow cucumbers) was the same as that evolved from the fermentations from which they were taken.

- 16.\* JONES, I. D.

SALTING OF CUCUMBERS: INFLUENCE OF BRINE SALINITY ON ACID FORMATION. Indus. and Eng. Chem., Vol. 32, No. 6, pp. 858-861. 1940.

A three-year study on the influence of brine concentration on acid formation during the fermentation of cucumbers in barrels revealed the following: Brines of low salt concentration gave rapid formation of a high amount of acid and a low pH. Increasingly higher initial brine strengths (10 to 21 percent) gave correspondingly slower rates of acid formation and lower amounts of acid produced.

- 17.\* JONES, I. D., VELDHUIS, M. K., ETCHELLS, J. L., and VEERHOFF, O.

CHEMICAL AND BACTERIOLOGICAL CHANGES IN DILL PICKLE BRINES DURING FERMENTATION. Food Res., Vol. 5, No. 5, pp. 533-547. 1940.

Various methods of manufacture of dill pickles under southern conditions were tested. The influence of brine concentration, addition of vinegar, lactic acid, and sugar upon bloater formation, and upon the fermentation as determined by chemical and bacteriological examination is reported. The percentages of bloaters in large sized stock (600 count per barrel) for some of the treatments were as follows: control, 20%; 26° sal. brine, 45%; lactic acid added at the start, 67%; sugar added after 1 week, 70%; and sugar added at the start, 78%.

18. VELDHUIS, M. K., ETCHELLS, J. L., JONES, I. D., and VEERHOFF, O.

INFLUENCE OF SUGAR ADDITION TO BRINES IN PICKLE FERMENTATION. Food Indus., Vol. 13, No. 10, pp. 54-56; No. 11, 48-50. (Oct.-Nov.) 1941.

This paper summarized the results of a series of experiments covering several brining seasons upon the addition of sugar to brines in the manufacture of salt-stock pickles or dill pickles. It is clearly demonstrated that added sugar not only fails to increase brine acidity to a useful degree, but also leads to an increase in the proportion of bloaters in the stock.



Article  
No.

19. JONES, I. D., and ETCHELLS, J. L.

PHYSICAL AND CHEMICAL CHANGES IN CUCUMBER FERMENTATION. Food Indus., Vol. 15, pp. 62-64. (Jan.) 1943.

Physical and chemical observations on cucumber fermentations covering several brining seasons are summarized. It was found that the use of low salt content brines, during the first five days of curing, favor rapid acid development and the production of a comparatively large amount of acid, but with only a small amount of gas. However, high salt content brines retard the rate of acid formation, reduce the amount formed, but favor a gaseous fermentation and bloater formation.

E. Bloaters (Hollow Cucumbers)

- 20.\* JONES, I. D., ETCHELLS, J. L., VEERHOFF, O., and VELDHUIS, M. K.

OBSERVATIONS ON BLOATER FORMATION IN CUCUMBER FERMENTATION. Fruit Prod. Jour. and Amer. Vinegar Indus., Vol. 20, No. 7, pp. 202-206; 219-220. (March) 1941.

Observations are presented with reference to the nature of proportion of bloaters (hollow cucumbers) formed in cucumbers receiving different curing treatments. It was concluded that bloater formation is related to a gaseous fermentation. Factors which favor the developments of a vigorous gaseous fermentation (additions of sugar, lactic acid, or acetic acid in sufficient amounts, or strong brines) favor the production of bloaters.

21. ETCHELLS, J. L., and JONES, I. D.

AN OCCURRENCE OF BLOATERS DURING THE FINISHING OF SWEET PICKLES. Fruit Prod. Jour. and Amer. Vinegar Indus., Vol. 20, No. 12, pp. 370, 381. (Aug.) 1941.

Bloater formation as reported in this case was attributed to the fact that the pickles were finished at too low an acidity. The chemical and bacteriological analyses of the fermented liquor, together with the analysis of the gas from the bloaters, indicated that yeasts were responsible for the spoilage involved.

SEE ALSO NOS. 11, 15, 17, 18, and 19.

Article  
No.

F. Pasteurized Pickles

22.\* ETCHELLS, J. L.

RATE OF HEAT PENETRATION DURING THE PASTEURIZATION OF CUCUMBER PICKLE. Fruit Prod. Jour. and Amer. Vinegar Indus., Vol. 18, No. 3, pp. 68-70. (Nov.) 1933.

The pasteurization of fresh cucumber pickle (sweet slices) was studied with particular emphasis placed on the rate of heat penetration to the center of glass jars of pickle, and the rate of heat loss during the subsequent cooling. Under the commercial conditions used, and with a batch operation, the water and jars reached 160° F. in about 30 and 60 minutes, respectively. The cooling operation was accomplished in approximately 25 minutes.

23.\* JONES, I. D., ETCHELLS, J. L., VELDHUIS, M. K., and VEERHOFF, O.

PASTEURIZATION OF GENUINE DILL PICKLES. Fruit Prod. Jour. and Amer. Vinegar Indus., Vol. 20, No. 10, pp. 304-305; 316; 325. (June) 1941.

The work demonstrates the desirability of pasteurizing genuine dill pickles to retain their firmness during storage. Dills which received pasteurizing treatments amounting to a maximum internal pickle temperature of 140, 160, and 167° F. retained a satisfactory degree of firmness for storage periods of a year to 16 months. This was in contrast to unpasteurized lots which rapidly became so soft that they were unusable.

24. ETCHELLS, J. L., and OHMER, H. B.

A BACTERIOLOGICAL STUDY OF THE MANUFACTURE OF FRESH CUCUMBER PICKLE. Fruit Prod. Jour. and Amer. Vinegar Indus., Vol. 20, No. 11, pp. 334-337; 357. (July) 1941.

The results of a routine bacteriological study of the manufacture of pasteurized, fresh cucumber pickle, under commercial conditions, and covering a four-year period (1937-1940) are reported. The findings showed that only the heat-resistant, spore-forming bacteria survived the pasteurizing procedure (160° F. for 20 minutes or 165° F. for 15 minutes) and that these organisms showed little or no increase during storage of the pickle.

Article  
No.

25. ETCHELLS, J. L., and JONES, I. D.

PASTEURIZATION OF PICKLE PRODUCTS. Fruit Prod. Jour. and Amer. Vinegar Indus., Vol. 21, No. 11, pp. 330-332. (July) 1942.

Pickle products requiring pasteurization during their manufacture have been placed in three general classes; namely unfermented, partially fermented, and fully fermented. Typical examples of products in each of these classes have been investigated with respect to the use of a uniform pasteurization procedure in all cases; namely, an internal product temperature of 165° F. for 15 minutes followed by prompt cooling. The results demonstrate that the organisms responsible for fermenting or otherwise deteriorating the products were killed. Also, most of the original crispness or firmness of the products was retained over a reasonably long storage period.

26. ETCHELLS, J. L., and JONES, I. D.

MORTALITY OF MICROORGANISMS DURING PASTEURIZATION OF CUCUMBER PICKLE. Food Res., Vol. 8, No. 1, pp. 33-44. 1943.

The results of a series of experiments dealing with the mortality of microorganisms during the pasteurization of cucumber pickle are presented. Procedures using temperatures of 120, 130, 140, 150, and 160° F. for 15 minutes were employed for pickle inoculated with acid-forming bacteria and yeasts as the test organisms. The pasteurizing treatment using 160° F. was sufficient to kill both acid-forming bacteria and yeasts in all pickle liquors used, irrespective of the quantity of inoculum employed.

27. ETCHELLS, J. L., and JONES, I. D.

THE IMPORTANCE OF CARE IN THE PASTEURIZATION OF PICKLE PRODUCTS. The Canner, Vol. 98, No. 9, pp. 28, 64. (Jan.) 1944.

The nature of the pasteurization procedure for pickles is discussed briefly and attention is directed to the cause of numerous pasteurization failures in commercial pickle plants. The importance of keeping records, checking the course of heating, proper cooling, container size, and adequate headspace in containers, are some of the points emphasized in connection with the pasteurizing process.

SEE ALSO NOS. 4 and 5.



Article  
No.

G. Softening Enzyme Studies

28. BELL, T. A., ETCHELLS, J. L., and JONES, I. D.

SOFTENING OF COMMERCIAL CUCUMBER SALT-STOCK IN RELATION TO POLY-GALACTURONASE ACTIVITY. Food Tech., Vol. 4, No. 4, pp. 157-163. (April) 1950.

A sensitive method is described for detecting a pectin-splitting enzyme in commercial cucumber brines. The enzyme compares similarly in chemical behavior to polygalacturonase and has been found present in cucumber brines from various brining areas and correlated with softening of the salt-stock.

29. BELL, T. A., ETCHELLS, J. L., and JONES, I. D.

PECTINESTERASE ACTIVITY IN THE CUCUMBER AND THE TOMATO. Incorporated in an address before the National Pickle Packers Association, June 16, 1950, Chicago, Illinois.

The seeds, leaves, petioles, stems, flowers, and fruit of the pickling cucumber (Cucumis sativus) were found to contain the de-esterifying enzyme pectinesterase. In the cucumber, the esterase content remains fairly constant throughout fruit development, but in the tomato (Lycopersicon esculentum) it increases very rapidly, to over 300 times the initial amount. The low esterase content of commercially brined cucumbers was attributed chiefly to inhibition of the enzyme by the acid resulting from the lactic fermentation.

30. BELL, T. A.

POLYGALACTURONASE ACTIVITY IN THE CUCUMBER AND TOMATO. Incorporated in an address before the National Pickle Packers Association, June 16, 1950, Chicago, Illinois.

The cucumber plant and fruit (Cucumis sativus) have been found to be a source of a polygalacturonase-like enzyme as measured by a loss in viscosity of a pectin solution. The seeds, staminate and pollinated pistillate flowers, and ripe fruits were strongly active but the enzyme was not found in the unpollinated flowers, leaves, petioles, and stems. The enzyme was not demonstrated in the embryos with flowers or in the green tomato fruit (Lycopersicon esculentum), but was readily found in the red-ripe fruit.



Article  
No.

31. ETCHELLS, J. L., and BELL, T. A.

PECTIN HYDROLYSIS BY YEASTS FROM COMMERCIAL CUCUMBER BRINES AND RELATED SOURCES. Incorporated in an address before the National Pickle Packers Association, June 16, 1950, Chicago, Illinois.

A total of 143 yeast cultures, representing 66 species and varieties in 15 genera, were investigated by use of a simplified screening technique for their ability to hydrolyze citrus pectin in culture media as indicated by de-esterification and glycoside hydrolysis. Species and varieties in the following 7 genera were able to de-esterify citrus pectin; Debaryomyces, 8 species; Candida, 4; Endomycopsis, 2; Hansenula, 3; Rhodotorula, 2; Zygopichia, 1; Torulopsis, 1; and unidentified, 3. Only 4 of the 143 cultures gave clear-cut tests for glycosidic hydrolysis. They were: Saccharomyces fragilis, Saccharomyces fragilis var., Saccharomyces species (Hall) from citrus concentrate, and unidentified yeast Y-659. All came from sources other than cucumber brines.

H. Varieties for Pickles

32. JONES, I. D., and ETCHELLS, J. L.

CUCUMBER VARIETIES IN PICKLE MANUFACTURE. The Canner, Vol. 110, No. 1, pp. 34, 36, 38, 40. (Jan. 7 issue) 1950.

Tests were conducted in several important pickle packing areas in the southern states with both the newer and the older pickling varieties. These studies included: Storage tests on fresh material; preparation of sweet pickle and pasteurized dills; and examination of salt-stock. It was found that wide differences in product quality occurred, and that those differences were associated with varietal characteristics.

I. Sanitation for Factories

33. ETCHELLS, J. L.

SUGGESTIONS REGARDING PICKLE PLANT SANITATION. Fruit Prod. Jour. and Amer. Food Mfr. Vol. 26, No. 2, pp. 45-48; 58. (Oct.) 1946.

The discussion of pickle plant sanitation is presented to serve as a guide and as suggestions for the National Pickle Packers Association. The material is organized on the basis of suggestions concerning: Premises, Manufacturing Practices, Personnel, and Methods of Analysis. It is pointed out that the progressive pickle packer can readily meet the reasonable and just sanitary obligations required by law irrespective of his locality. To those that are less progressive, it hardly seems a matter of what they want to do, but rather what is expected of them in the best interests of the customer.

## II. OTHER VEGETABLES: BRINING AND PICKLING

### A. General

34. ETCHELLS, J. L., and JONES, I. D.

COMMERCIAL BRINE PRESERVATION OF VEGETABLES. Fruit Prod. Jour. and Amer. Vinegar Indus., Vol. 22, No. 8, pp. 242-246, 251, 253. (April) 1943.

A general report of a war-time study on the brine preservation of certain vegetables is given. Included in the study were green snap beans, green peas, lima beans, yellow wax beans, carrots, and certain leafy vegetables, such as, turnip greens, mustard greens and kale. Recommendations for the routine brining of the vegetables investigated are included. Vitamin retention with respect to carotene (pro-vitamin A) and vitamin C is reported for certain of the vegetables brined.

35. ETCHELLS, J. L., JONES, I. D., and HOFFMAN, M. A.

BRINE PRESERVATION OF VEGETABLES. Proc. Inst. Food Tech., pp. 176-182. (June) 1943.

The results on the brining of various types of vegetables is presented in connection with the over-all possibilities of brine preservation as an emergency method for storing foods. The experiments demonstrate that brine preservation methods based on different degrees of refinement may be satisfactorily employed for storing large quantities of vegetable material in bulk until further processing can be carried out.

### B. Methods and Procedure

36. ETCHELLS, J. L., and JONES, I. D.

PRESERVATION OF VEGETABLES BY SALTING OR BRINING. U. S. Dep't Agric. Farmers' Bul. 1932, 14 pp. (Sept.) 1943. Revised (June) 1944.

Salting or brining is a good way to preserve vegetables, especially when you cannot freeze or can them. The method is inexpensive and not difficult for home use. Sauerkraut, made by salting cabbage, is well known and widely used. This bulletin tells how to put up a number of other vegetables besides cabbage.

SEE ALSO No. 34.

Article  
No.

C. Bacteriological Studies

37. ETCHELLS, J. L., JONES, I. D., and LEWIS, W. M.

BACTERIOLOGICAL CHANGES DURING THE FERMENTATION OF CERTAIN BRINED AND SALTED VEGETABLES. U. S. Dep't of Agric. Tech. Bul. 947, 64 pp. (Oct.) 1947.

In most instances, microbial activity of varied intensity accompanied vegetable preservation by salting or brining, and was present over a wide range with respect to both the type of vegetable and the amount of salt used. The predominating groups of microorganisms found were: The acid-forming bacteria, the coliform bacteria, the yeasts, and the coccus forms. The influence of salt concentration upon the above microbial groups is discussed. The bulletin contains an appendix which describes in detail the bacteriological media and methods used in the work.

D. Nutritive Value

- 38.\* JONES, I. D., and ETCHELLS, J. L.

NUTRITIVE VALUE OF BRINED AND FERMENTED VEGETABLES. Amer. Jour. Pub. Health, Vol. 34, No. 7, pp. 711-718. (July) 1944.

The results demonstrate that certain vegetables which are important sources of proteins, starches, and minerals are well adapted to brine preservation and can be used as non-pickle products. Furthermore, it was shown that these constituents are well retained in such brine preserved vegetables. The greatest conservation of nutrients is accomplished by using the brined material without desalting, such as in the preparation of soups or certain vegetable mixtures.

- 39.\* JONES, I. D., and ETCHELLS, J. L.

FOOD VALUE OF BRINED VEGETABLES. N. C. Agr. Expt. Sta., Quarterly Pub., Research and Farming, Vol. 4, Progress Report 1, pp. 1-2;12. (Oct.) 1945.

This is a popular revision of the paper which appeared in the American Journal of Public Health, Vol. 34, pp. 711-718, 1944, and is abstracted above (No. 38) under the title "Nutritive Value of Brined and Fermented Vegetables."

SEE ALSO No. 34.

Article  
No.

III. MISCELLANEOUS

(Silage)

40. NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION and BUREAU OF AGRICULTURAL AND INDUSTRIAL CHEMISTRY (USDA).

SWEET POTATO VINE SILAGE. N. C. Agr. Expt. Sta., Circular No. 3, 3 pp. (Oct.) 1944.

This circular describes briefly how to make silage from sweet potato vines.

41. ETCHELLS, J. L., and JONES, I.D.

BACTERIOLOGICAL CHANGES DURING THE FERMENTATION OF STEAMED POTATOES FOR SILAGE. Jour. Agr. Res., Vol. 78, Nos. 1 and 2, pp. 19-31. 1949.

The results of a bacteriological examination of the fermentation hot-ensiled steamed potatoes (Solanum tuberosum) are reported. The findings demonstrate that thermophilic, facultative anaerobes were the predominating microorganisms present during the fermentation and were responsible for the developed acidity and resultant preservation of the silage. These organisms may be classified according to Bergey et al, as thermophiles belonging in Group X of the genus Bacillus.

